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The Influence of Demographic and Insurance Factors on Hospitalization Rates, Treatment Costs, and Length of Stay for Sickle Cell Disease Patients among African Americans

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ABSTRACT

This study examines the influence of demographic and insurance variables on hospitalization rates, treatment costs, and length of stay (LOS) for Sickle Cell Disease (SCD) patients among African Americans from 1998 to 2020. SCD is a significant public health issue, particularly affecting African American populations, where it leads to frequent hospitalizations and substantial healthcare costs. The research analyzes demographic factors such as age and gender, revealing that adult males tend to experience higher hospitalization rates and longer LOS compared to other groups. Furthermore, the type of insurance coverage significantly impacts treatment costs, with patients using private insurance or self-pay options incurring greater financial burdens than those enrolled in government programs like Medicaid and Medicare. Through a comprehensive analysis of hospitalization data, treatment expenses, and patient demographics, the study aims to provide critical insights that can inform healthcare policies and interventions designed to improve health outcomes for African American SCD patients. The findings underscore the need for targeted healthcare strategies that consider demographic disparities and the role of insurance in accessing care.

Keywords: Sickle Cell Disease (SCD), Hospitalization Rates, Length of Stay (LOS), Healthcare Costs, Insurance Type, Demographic Factors, Treatment Costs, Healthcare Disparities

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INTRODUCTION

Sickle Cell Disease (SCD) is a significant public health concern, particularly among African American populations, where it affects approximately 1 in 365 individuals (Hassell, 2010). This genetic disorder is characterized by the production of abnormal hemoglobin, which causes red blood cells to become rigid and sickle-shaped. These misshapen cells can obstruct blood flow, leading to severe pain episodes, organ damage, and increased susceptibility to infections (Rees, Williams, & Gladwin, 2010). Consequently, SCD leads to a myriad of health complications that result in substantial healthcare utilization, including frequent hospitalizations and extended lengths of stay (LOS) in healthcare facilities. Understanding the factors that influence hospitalization rates, treatment costs, and LOS for SCD patients is critical for developing effective healthcare policies and interventions tailored to the needs of this population.

Demographic variables such as age and gender have been shown to significantly impact the clinical outcomes of SCD. Research indicates that adult patients often experience higher hospitalization rates and longer LOS compared to pediatric patients. For instance, Ballas (2013) emphasizes that adults with SCD are more likely to experience complications such as acute chest syndrome and stroke, necessitating more frequent hospital admissions. Furthermore, gender disparities in disease manifestation have been noted, with males typically facing more severe symptoms and complications associated with SCD. This has been linked to biological differences and potentially greater psychosocial stressors, which collectively contribute to higher healthcare utilization among male patients (Ballas et al., 2012).

Additionally, the type of insurance coverage plays a crucial role in determining treatment access and associated costs. Studies have shown that patients with private insurance or those who self-pay often incur significantly higher treatment costs compared to those covered by government programs such as Medicaid or Medicare, which can mitigate financial burdens (Gonzalez et al., 2017). The type of insurance not only influences the economic aspects of care but also affects the quality and timeliness of treatment. For example,

patients with private insurance may have better access to specialized care and medications, whereas those reliant on government assistance may face barriers due to limitations in provider networks and reimbursement rates (Gonzalez et al., 2017).

This study aims to explore the influence of demographic and insurance variables on hospitalization rates, treatment costs, and LOS among African American SCD patients from 1998 to 2020. By examining these factors, the research seeks to contribute valuable insights that can inform healthcare practices and policies aimed at improving health outcomes for this vulnerable population. Furthermore, understanding the interplay between demographic factors and insurance coverage will help identify disparities in care that can be addressed through targeted interventions. Ultimately, this research aims to provide a comprehensive understanding of the multifaceted issues surrounding SCD, paving the way for more equitable healthcare delivery and improved patient outcomes.

LITERATURE REVIEW

Hospitalization Patterns

Research highlights that individuals with sickle cell disease (SCD) face significantly higher hospitalization rates than the general population. These hospitalizations are often due to recurring pain crises and complications related to the disease. By age 60, a patient with SCD may incur healthcare costs exceeding $1 million, largely due to frequent hospital admissions and the need for multidisciplinary care (Brousseau et al., 2010). From 2005 to 2014, SCD hospitalization rates remained relatively stable, averaging around 96,936 annual admissions. Among these, 87% involved African American patients, and 42% were for children under the age of 18 (Lee et al., 2020).

High hospitalization rates in SCD are particularly associated with frequent vaso-occlusive crises, which cause severe pain and risk long-term organ damage. These crises can be triggered by factors such as dehydration, infection, and extreme temperatures (Ballas, 2018). Acute complications like acute chest syndrome and stroke also frequently necessitate hospitalization for aggressive medical treatment (Benenson et al., 2017). Despite advances in treatment, the persistently high hospitalization rates over the past decade indicate that SCD remains a major source of morbidity and a significant strain on healthcare resources. Without a decline in hospital admissions, there is a pressing need for effective interventions to prevent acute complications and reduce unnecessary hospitalizations.

Healthcare Costs

The financial burden of managing SCD has garnered significant attention due to its increasing costs. Factors such as poverty, barriers to care, and inadequate health insurance contribute to higher healthcare disparities and hospitalization rates among African Americans with SCD. Inpatient care costs for SCD patients in the U.S. were estimated at $811 million in 2016, rising to $1.2 million by 2020 (Huazhi et al., 2009).

Several factors drive the rising costs of SCD care. Managing acute complications like vaso-occlusive crises and acute chest syndrome requires intensive, expensive treatments (Gardener, 2018). Additionally, the frequent need for blood transfusions, hydroxyurea therapy, and other disease-modifying treatments further inflates healthcare expenses. In 1996, the average cost of a single hospitalization for an SCD patient was $6,300 (Davis et al., 1997). The financial burden is particularly severe for low-income and uninsured patients, who face significant out-of-pocket costs for copays, deductibles, and medications, creating barriers to healthcare access (Lee et al., 2019). Socioeconomic disparities exacerbate these challenges, leading to increased financial burdens on families affected by SCD (Kanter et al., 2020).

Factors Affecting Hospitalization Rates, Treatment Costs, and Health Outcomes in Sickle Cell Disease (SCD)

Several interconnected factors impact hospitalization rates, treatment costs, and overall health outcomes for individuals with sickle cell disease (SCD). These factors include the discussions below:

Socioeconomic Status (SES)

Socioeconomic status significantly influences healthcare access, quality of care, and health outcomes for SCD patients. Those from lower-income backgrounds face barriers such as limited access to transportation, language difficulties, and cultural differences, which can delay diagnosis and hinder effective management of chronic complications. These barriers often result in higher hospitalization rates and increased disease severity. Inadequate access to routine care leads to more frequent emergency visits, exacerbating health disparities in low-income populations (Lee et al., 2019).

Access to Specialized Care

Access to specialized care, such as through sickle cell centers, is a major determinant of health outcomes for SCD patients. Those with access to specialized care tend to experience fewer hospitalizations and lower healthcare costs compared to patients receiving fragmented care or relying on emergency departments. Specialized care helps in the proactive management of the disease, preventing acute complications and reducing the need for hospital admissions. However, regional disparities in access to these centers mean that many communities lack the necessary resources, leading to worse outcomes in those areas (Ye et al., 2016).

Insurance Type

Insurance coverage plays a critical role in determining the quality and accessibility of care. SCD patients with private insurance generally experience better health outcomes and lower overall treatment costs compared to those with Medicaid or no insurance. Patients with inadequate insurance coverage often face financial barriers that limit access to preventive services, necessary medications, and specialized care. This results in poorer health outcomes and higher costs from frequent hospitalizations and emergency care (Lee et al., 2019).

Acute Complications

The severity and frequency of acute complications, such as vaso-occlusive crises and acute chest syndrome, are major drivers of hospitalization rates and treatment costs. These complications often require intensive medical interventions, including hospitalization and long-term management, which contribute significantly to the overall economic burden of SCD care (Gardener, 2018). Effective management of these crises is critical to reducing hospital admissions and improving patient outcomes.

Preventive Care and Treatment

Preventive care measures, including regular blood transfusions, hydroxyurea therapy, and other disease-modifying treatments, can lower the frequency of acute complications and hospitalizations. However, the cost of these treatments is high, and access to them may be limited by socioeconomic factors or inadequate insurance coverage. Lack of access to preventive care increases the likelihood of acute complications, resulting in higher hospitalization rates and greater healthcare costs (Ballas, 2018).

Age and SCD Type

Hospitalization rates and healthcare costs also vary by age and SCD subtype. Younger patients, particularly those under 18, tend to have higher hospitalization rates due to complications that arise early in life. SCD subtypes, such as HbSS, are associated with more severe complications and higher costs compared to other forms of the disease. Tailoring interventions based on patient age and SCD subtype can help improve outcomes and reduce hospitalizations (Lee et al., 2020).

Regional Variability

Geographic disparities in healthcare access, including proximity to sickle cell centers and availability of specialized care, contribute to differences in hospitalization rates and health outcomes. Regions with limited healthcare infrastructure may see higher hospitalization rates due to lack of early intervention and preventive

care, leading to more severe complications over time. In summary, factors such as socioeconomic status, access to specialized care, insurance type, frequency of acute complications, preventive care availability, patient age, SCD subtype, and regional variability all play crucial roles in determining hospitalization rates, treatment costs, and health outcomes for SCD patients. Addressing these factors through targeted interventions can help reduce disparities and improve quality of life for individuals living with SCD.

METHODOLOGY

This study employs a quantitative research design and utilizes secondary data derived from the National Hospital Discharge Surveys (NHDS). The data spans the years 1998 to 2020 and includes information on hospital admissions for patients with Sickle Cell Disease (SCD). The dataset contains detailed records of patient demographics, clinical characteristics, insurance status, and hospitalization details, which provide comprehensive insights into hospitalization patterns for SCD patients over the selected time period. The analysis focuses on the following key variables: *Hospitalization Rates (HPR):* The frequency of hospital admissions for SCD patients, reflecting overall disease burden. *Length of Stay (LOS):* The number of days a patient remains hospitalized, indicating the intensity and complexity of care required. *Hospital Treatment Costs (HTC):* The total medical costs incurred during each hospitalization, providing insight into the economic burden of SCD care. *Patient Age and Gender:* These demographic variables (i.e. Children (<18), Adult ((≥18), Males, and Females) are considered to assess their impact on hospitalization rates, length of stay, and treatment costs. *Type of Clinical Consequences (TCCC)*: Includes acute and chronic complications related to SCD, such as vaso-occlusive crises, acute chest syndrome, and organ damage. *Patient Insurance Type (PIT):* Categorized into private insurance, public insurance (e.g., Medicaid), and uninsured, to examine disparities in access to care and associated costs.

To explore relationships between the study variables and uncover significant predictors of hospital resource utilization, two key analytical techniques were applied: (a) *Pearson Correlation Analysis*: This method was used to measure the strength and direction of linear relationships between continuous variables, such as the relationship between patient age and length of stay, or between hospitalization rates and treatment costs. (b) *Regression Analysis*: Multiple linear regression models were employed to assess the combined influence of independent variables like age, gender, clinical complications, and insurance type on hospitalization rates, length of stay, and treatment costs. These models allowed for the prediction of healthcare outcomes and the identification of significant predictors across the dataset. The combination of Pearson correlation and regression analysis provided robust quantitative insights into the factors influencing hospitalizations and the economic impact of SCD.

For the Case of the Predictors of Hospitalization Rates, Length of Stay, and Hospital Cost, three multiple regression equations are used. The following are three regression models used to analyze the relationships between various predictors and the outcomes of interest:

$$HPR = \alpha_0 + \alpha_1 *Males + \alpha_2 *Adult + \alpha_3 *ChN + \alpha_4 GIM + \alpha_5 PI + u \ldots\ldots\ldots\ldots (1)$$

$$LOS = \alpha_0 + \alpha_1 *Males + \alpha_2 *Adult + \alpha_3 *ChN + \alpha_4 GIM + \alpha_5 PI + u \ldots\ldots\ldots\ldots (2)$$

$$HTC = \alpha_0 + \alpha_1 *Males + \alpha_2 *Adult + \alpha_3 *ChN + \alpha_4 GIM + \alpha_5 PI + \alpha_6 LS + u \ldots\ldots\ldots (3)$$

Where, α_0= constant term, α_1= coefficient of male patients with SCD, α_2= coefficient of Adult with SCD, α_3= coefficient of Children (ChN) with SCD, α_4= coefficient of Government Insurance (GIM), α_5= coefficient of Private Insurance (PI), and α_6= coefficient of length of stay (LS) in equation 3, and u=error term. The three equations suggest a multiple regression framework where each outcome is regressed on the same set of predictors. The analysis could provide insight into which variables significantly influence hospitalization rates, length of hospital stay, and associated costs.

RESULTS AND ANALYSIS

Table 1

Correlation Analysis between Log of Hospitalization Rates and All the Independent Variables, Except for LOS (N=1998-2020)

Variables	1	2	3	4	5	6	7	8	9
1. Hospitalization Rates	1								
2. Males	0.503**	1							
3. Females	0.163	-0.648**	1						
4. Adult (≥18)	0.817**	-0.361	0.235	1					
5. Children (<18)	0.636**	0.381	0.023	-0.557**	1				
6. Government Insurance (Medicaid & Medicare)	-0.275	0.058	0.018	-0.508*	-0.083	1			
7. Private Insurance (HMO)	0.586**	-0.455**	0.168	-0.089	-0.266	0.322	1		
8. Self-Pay (Out-of-Pocket)	0.685**	-0.040	0.503	-0.542**	0.326*	0.199	0.228	1	
9. Type of Acute & Clinical Consequence for SCD	-0.479	-0.510	0.647	7.534*	0.734	0.651	0.758	0.595*	1
*Note: * p < 0.10, ** p < 0.05, *** p< 0.01. Log= logarithm, SCD=Sickle Cell Disease*									

Source: Author's summary of the correlation output from SPSS 20.0

Table 1 displays the results of the bivariate correlation analysis for all study variables. The table reveals several significant relationships between hospitalization rates and demographic or insurance variables for Sickle Cell Disease (SCD) patients from 1998 to 2020. First, there is a moderate positive significant relationship between hospitalization rates and male SCD patients (Pearson's correlation coefficient = 0.503**), indicating that male SCD patients are more likely to experience higher hospitalization rates. In contrast, the relationship between hospitalization rates and female SCD patients is weak and nonsignificant (r = 0.163), suggesting no clear association. Regarding age groups, the analysis shows a strong positive significant relationship between SCD children (under 18) and hospitalization rates (r = 0.636**), meaning children with SCD are more likely to have frequent hospitalizations. For adult SCD patients (18 years and above), the correlation is even stronger (r = 0.817**), indicating that adults with SCD are highly likely to experience frequent hospitalizations. These findings align with previous research (Alker, Kenney, & Rosenbaum, 2020; Center for Medicare and Medicaid Services, 2020; Hughes et al., 2015), which similarly found a strong positive relationship between age and hospitalization rates for SCD patients.

For healthcare financing, the analysis shows a weak negative relationship between hospitalization rates and government insurance (Medicaid or Medicare) (r = -0.275), suggesting that SCD patients with government insurance tend to experience lower hospitalization rates. On the other hand, there is a moderate positive relationship between private insurance and hospitalization rates (r = 0.586**), and a strong positive relationship between out-of-pocket payment and hospitalization rates (r = 0.685**). These findings are consistent with studies by Alker, Kenney, and Rosenbaum (2020) and the Center for Medicare and Medicaid Services (2020), which found higher hospitalization rates for SCD patients with private insurance and lower rates for those with government insurance.

Table 2

Correlation Analysis of Cost, Length of Stay in Hospitals and Independent Variables (N=1998-2020)

Variables	1	2	3	4	5	6	7	8	9	10
1. Cost of Treatment	1									
2. Males	0.531**	1								
3. Females	0.263	-0.746**	1							
4. Adult ((≥18)	0.917**	-0.353	0.227	1						
5. Children (<18)	0.757**	0.377	0.023	-0.548**	1					
6. Government Insurance (Medicaid & Medicare)	-0.187	0.062	0.018	-0.506*	-0.094	1				
7. Private Insurance (HMO)	0.595**	-0.565**	0.177	-0.089	-0.266	0.307	1			
8. Self-Pay (Out-of-Pocket)	0.778**	-0.030	0.403	-0.647**	0.426*	0.099	0.126	1		
9. Type of Acute & Clinical Consequence for SCD	-0.379	-0.710	0.747	6.534*	0.435	0.451	-3.188	0.595*	1	
10. Length of Stay	0.939***	0.452*	0.921***	0.095	0.219	-0.100	0.312	0.467*	-0.217	1

*Note: * p < 0.10, ** p < 0.05, *** p< 0.01. Log= logarithm, SCD=Sickle Cell Disease*

Source: Author's summary of the correlation output from SPSS 20.0

Table 2 presents the results of the bivariate correlation analysis for all study variables. The table reveals several significant relationships between the cost of treatment and demographic or insurance variables for Sickle Cell Disease (SCD) patients from 1998 to 2020. First, there is a moderate positive significant relationship between the cost of treatment and male SCD patients (Pearson's correlation coefficient = 0.531**), indicating that male SCD patients tend to incur higher treatment costs. In contrast, the relationship between treatment costs and female SCD patients is weak and nonsignificant (r = 0.253), suggesting no strong association between gender and treatment costs for female patients.

Regarding age groups, the analysis shows a strong positive relationship between the cost of treatment for children under 18 and hospitalization (r = 0.757**), meaning that younger SCD patients are likely to face higher treatment costs. For adult SCD patients (18 years and above), the correlation is even stronger (r = 0.917**), indicating that adults with SCD are more likely to face substantial medical bills. These findings are consistent with previous research (Alker, Kenney, & Rosenbaum, 2020; Center for Medicare and Medicaid Services, 2020; Hughes et al., 2015), which similarly found a strong positive relationship between treatment costs and patient demographics such as age and gender.

For healthcare financing, the analysis shows a weak negative relationship between treatment costs and government insurance (Medicaid or Medicare) (r = -0.187**), indicating that SCD patients with government insurance are likely to pay lower or no out-of-pocket costs for treatment. On the other hand, there is a moderate positive relationship between private insurance and treatment costs (r = 0.595**), and a strong positive relationship between out-of-pocket payments and treatment costs (r = 0.778**). These findings align with studies by Alker, Kenney, and Rosenbaum (2020) and the Center for Medicare and Medicaid Services (2020), which found higher out-of-pocket payments for SCD patients with private insurance and lower costs for those with government coverage.

Additionally, the analysis shows a significant and strong positive relationship between the length of hospital stay and the cost of treatment (r = 0.939***). This indicates that the longer SCD patients remain in the hospital, the higher their treatment costs, all other factors being equal.

Table 3

Multiple Regression Estimates Predicting Logged Length of Stay in Hospitals, Hospitalization Rates, and Cost of Treatment for SCD Patients (1998-2020)

Variables	Hospitalization Rates/ Hospital Rates (Model 4)		Length of Stay in Hospital Model (Model 5)		Cost of Treatment Model (Model 6)	
	B	Beta	B	Beta	B	Beta
Gender (SCD Male Patients)	0.452** (0.156)	0.418	0.460** (0.166)	0.422	0.425** (0.161)	0.370
Adult ((≥18)	0.461** (0.373)	0.424	0.446** (0.381)	0.443	0.613** (0.333)	0.182
Children (<18)	0.577** (0.228)	0.475	0.583** (0.239)	0.483	0.589** (0.266)	0.343
Government Insurance (Medicaid & Medicare)	-0.32 (0.336)	-0.146	-0.22 (0.324)	-0.026	-0.258** (0.019)	-0.248
Private Insurance/HMO	0.678*** (0.056)	0.589	0.703*** (0.064)	0.613	0.977*** (0.108)	0.955
Self-pay/Out-of-Pocket Payment	0.315** (0.035)	0.274	0.326** (0.046)	0.279	0.561** (0.188)	2.491
Length of Stay					0.424** (0.194)	0.341
Constant	12.696*** (3.401)		12.598*** (3.396)		17.624*** (5.097)	
F-statistics	5.036**		4.238**		5.349**	
R^2	0.774		0.654		0.835	
Adjusted R^2	0.613		0.563		0.669	

Source: Author's summary of the multiple regression output from SPSS 20.0 and National Hospital Discharge Survey

Table 3 presents the results from multiple regression analyses across three models that examine hospitalization rates, length of stay, and treatment costs for Sickle Cell Disease (SCD) patients. As explained earlier in the method section, Model 1 investigates the factors influencing hospitalization rates for SCD patients by considering variables such as gender (SCD male patients), age group (adults and children), and healthcare financing type or insurance type (e.g., government insurance—Medicaid or Medicare, private insurance/HMO, and self-pay/out-of-pocket payment). In Model 2, the same independent variables—gender, age group, and insurance type—are used to predict the factors affecting the length of stay for SCD patients. Model 3, which examines the cost of treatment, introduces the length of hospital stay as an additional variable, based on literature suggesting that longer hospital stays contribute to higher treatment costs. Therefore, in Model 3, the factors influencing the cost of treatment for SCD patients include gender, age group, length of hospital stay, and healthcare financing type or insurance. All three models were evaluated at a 5% significance level (0.05). However, given the small sample size of 23 years (1998–2020), the study also considered a more relaxed 10% significance level (0.10), following the approach of Hughes et al. (2015), if statistical power appeared limited. Table 3 provides both standardized and unstandardized coefficients for each variable across the three models. For clarity and consistency in interpreting the results, the discussion focuses solely on the standardized coefficients.

CONCLUSION AND POLICY IMPLICATIONS

The study provides significant insights into the factors influencing hospitalization rates, treatment costs, and length of stay among African American patients with Sickle Cell Disease (SCD) from 1998 to 2020. Notably, both male and female SCD patients experience hospitalization; however, males show a stronger positive relationship with hospitalization rates. Furthermore, both adults and children with SCD face frequent hospitalizations, with adults exhibiting the most substantial correlation with these rates. Additionally, patients with private insurance and self-pay options tend to experience higher hospitalization rates compared to those with government insurance, such as Medicaid or Medicare, which is negatively correlated with hospitalization.

In terms of treatment costs, the study reveals a positive correlation between hospitalization and treatment expenses, particularly for male SCD patients and adults. Those utilizing self-pay and private insurance options incur higher treatment costs, while government insurance appears to alleviate the financial burden associated with hospitalization.

Moreover, the length of stay (LOS) in hospitals is significantly correlated with increased treatment costs. Male patients and those using self-pay options often endure longer hospital stays, which further exacerbates treatment expenses. Given these findings, the study recommends specific policies to address the observed disparities and improve outcomes for African American SCD patients.

Policy Implications:

- **Gender-Based Interventions**: Since male SCD patients face higher hospitalization rates and treatment costs, targeted healthcare programs addressing the unique needs of this group are essential. Gender-specific interventions may reduce hospitalization and the financial burden on this demographic.
- **Insurance Reform**: The higher hospitalization rates and treatment costs associated with private insurance and self-pay indicate a need for policy reforms to improve healthcare affordability. Expanding government insurance coverage, reducing co-payments, and making private insurance more accessible to SCD patients may alleviate the financial strain.
- **Age-Specific Healthcare Policies**: Since adults and children with SCD face high hospitalization rates, age-specific interventions, such as increased monitoring and preventative care, should be prioritized. Tailored healthcare plans that reduce hospital visits and enhance treatment outcomes for these age groups can improve the quality of life for SCD patients.
- **Cost Control Measures**: Policies aimed at reducing the length of hospital stays could lower overall treatment costs. Incentives for outpatient care, home-based treatments, or advanced healthcare technologies could minimize the time SCD patients spend in hospitals, reducing both cost and resource strain.

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